

Solar Occultation For Ice Experiment (SOFIE)

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SOFIE is part of the AIM mission

Aeronomy of Ice in the Mesosphere

AIM will study noctilucent clouds (NLCs) to determine how they form and why they vary



- AIM was selected as a NASA Small Explorers (SMEX) mission in July 2002
- AIM was confirmed for flight April 2004
- AIM is scheduled for launch in September 2006

Noctilucent Clouds (NLC)

- Highest altitude clouds in our atmosphere (83 km)
- Occur pole-ward of $\sim 50^\circ$ latitude, both hemispheres
- Summer phenomena
- Composed of water ice crystals (~ 50 nm radius)

Noctilucent means “night shining”

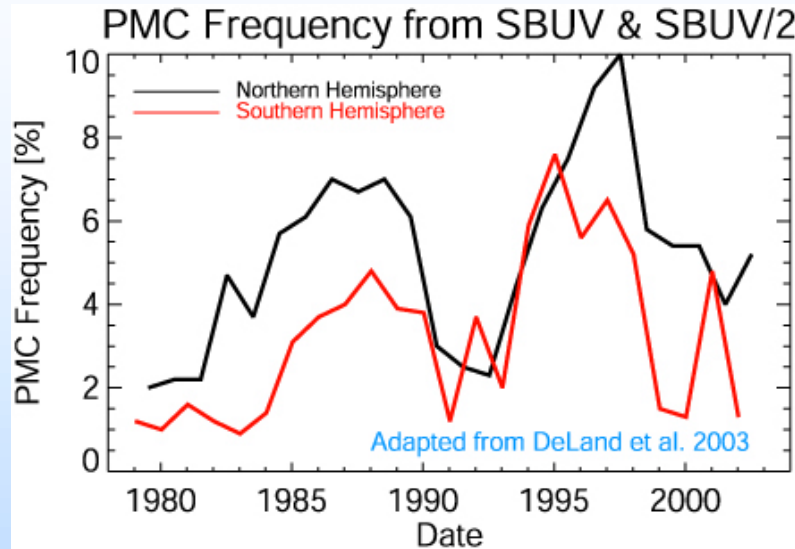
NLCs are also known as

“polar mesospheric clouds” (PMCs)



Motivation for AIM: NLCs are changing

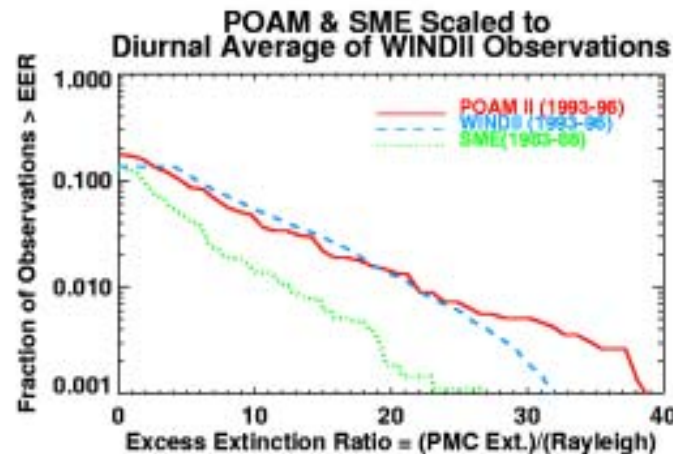
Increasing numbers are occurring



NLCs are moving equatorward



Brighter NLCs are being observed



WHY ?

The AIM Mission



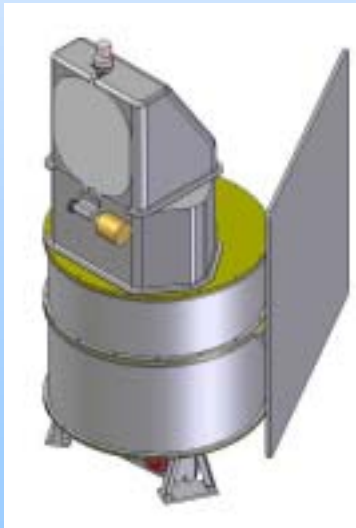
OSC, Dulles

Orbit: 600 km, polar, sun-synchronous

Minimum Life: 24 months (4 NLC seasons)

Payload: 3 science instruments

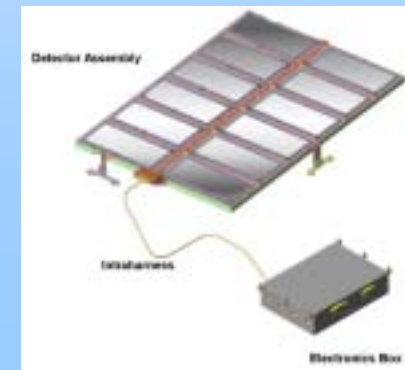
SOFIE (Solar Occultation For Ice Experiment):
SDL, Logan



CIPS (Cloud Imaging and Particle Size):
LASP, Boulder



CDE (Cosmic Dust Experiment):
LASP, Boulder

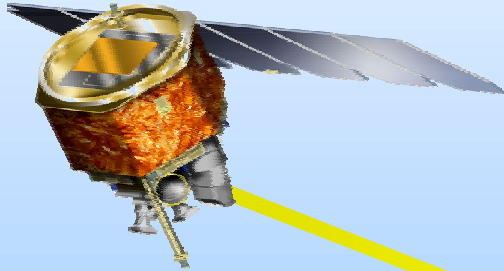


AIM Common Volume Observations

**CIPS and SOFIE observe the same volume each orbit
with 6 minutes Δt**

SOFIE:

vertical profiles of
NLC extinction and size distribution,
thermal and chemical environment



CIPS:

horizontal NLC structure
and particle size



SOFIE Measurement Overview

- Broadband differential absorption measurements:
 - Gas abundance: H_2O , O_3 , CH_4 , NO , CO_2
 - Particle extinction: 10 wavelengths from 0.29 to 5.3 μm
 - Temperature
- High signal-to-noise: 10^6 to 10^9
- Precise solar tracking: 2 arcsec precision

SOFIE Channel Summary

channel	1	2	3	4	5	6	7	8
Target	O_3	particles	H_2O	CO_2	particles	CH_4	CO_2	NO
Center λ (μm)								
Strong band	0.290	0.862	2.60	2.77	3.06	3.37	4.25	5.32
Weak band	0.328	1.031	2.45	2.94	3.19	3.51	4.63	4.98

Differential Absorption Measurements

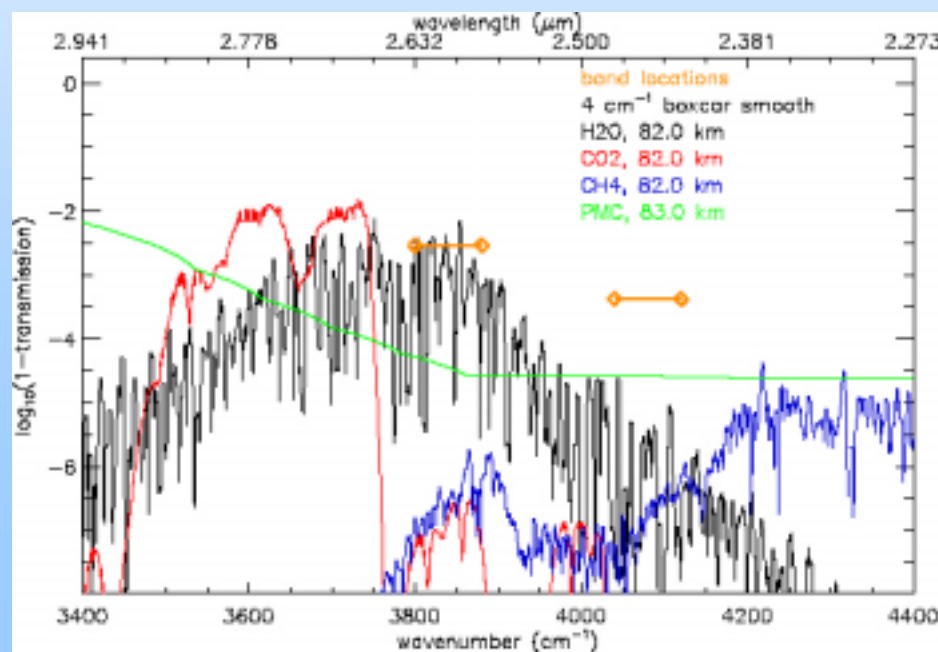
Each SOFIE channel uses two detectors to make three measurements:

- Strong band absorption
- Weak band absorption
- Difference signal (weak band – strong band)

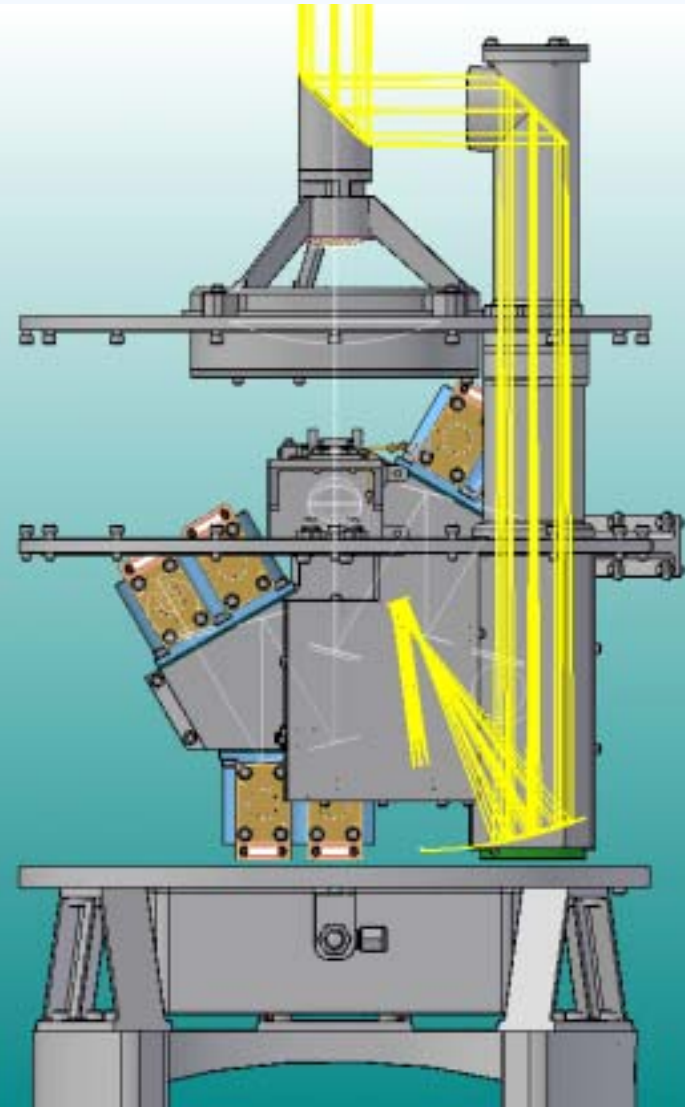
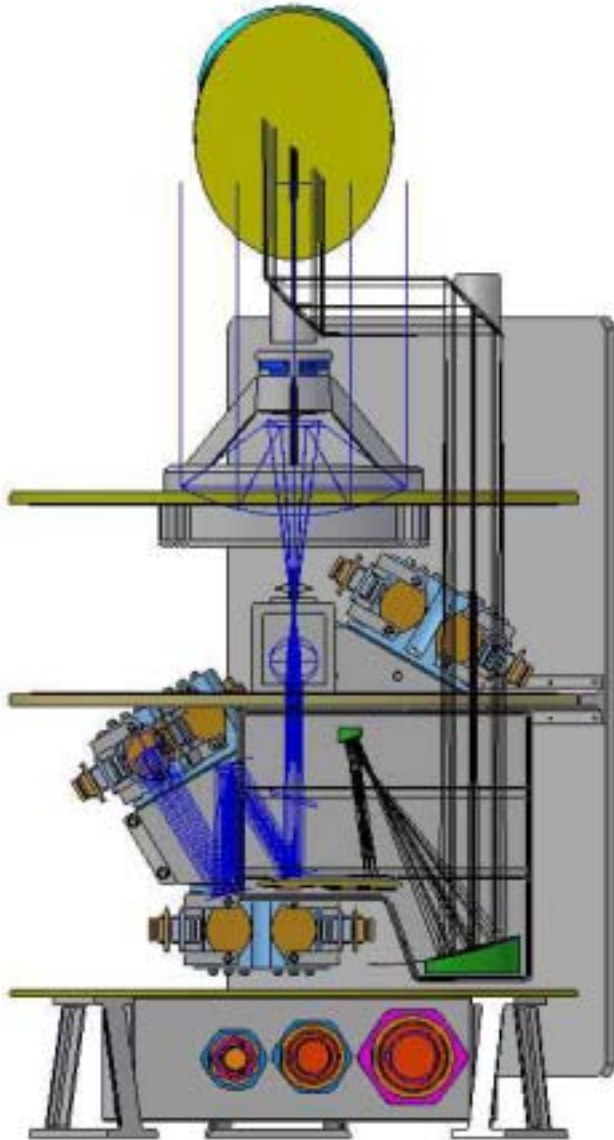
Difference signal measurements remove interference and reduce noise

Simultaneous NLC, temperature, and gas measurements

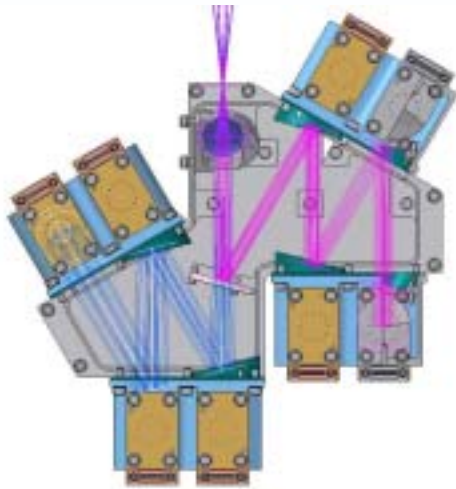
SOFIE targets the
mesosphere and above,
but will easily obtain
stratospheric measurements



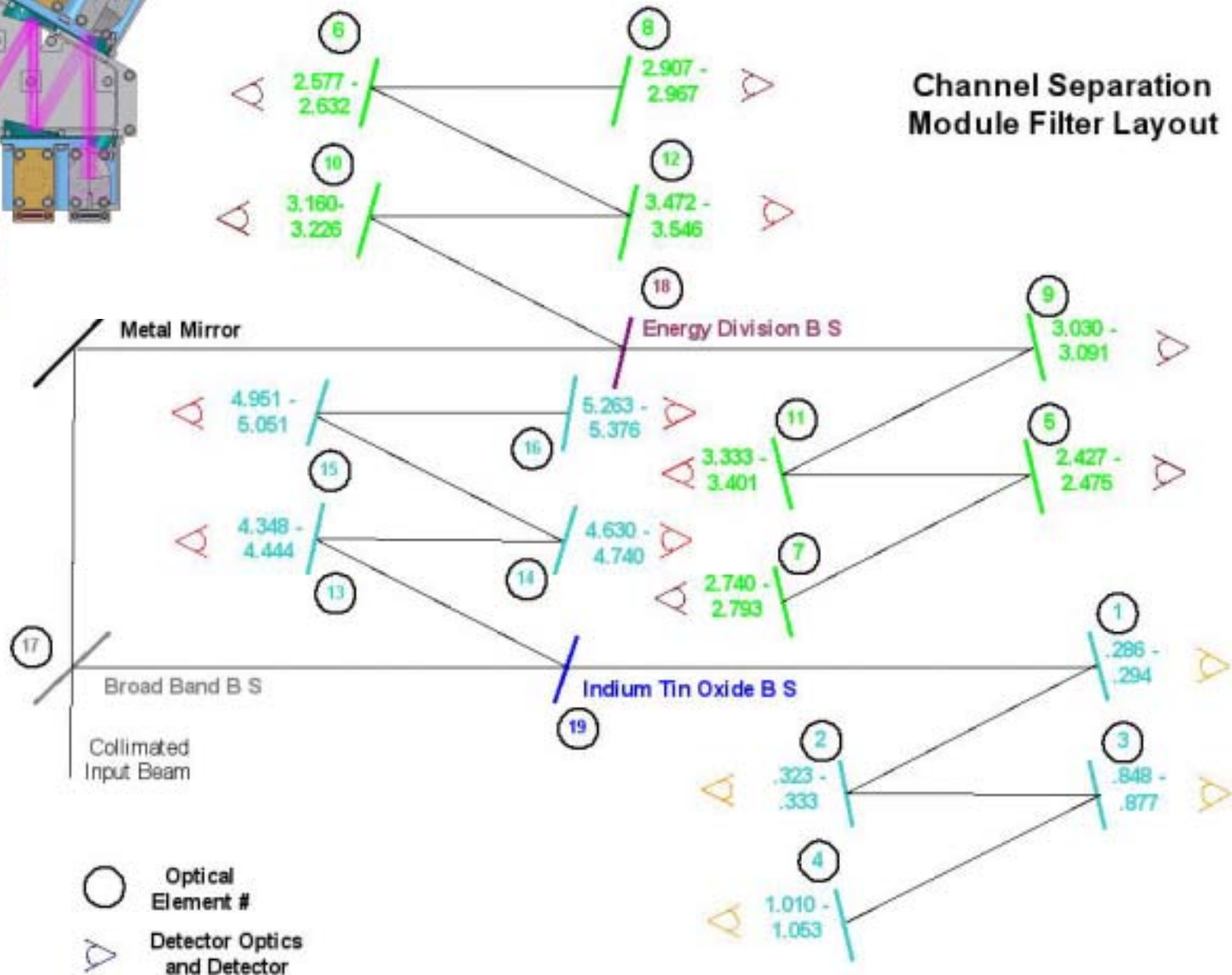
SOFIE Optical Layout



Channel Separation Module



Channel Separation Module Filter Layout



SOFIE Temperature Measurements

Based on 3 Measurements:

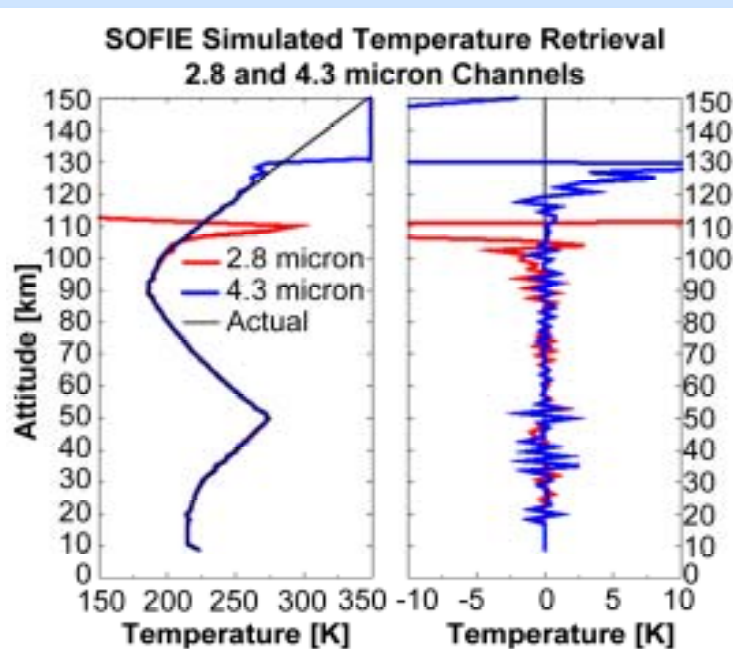
- Differential CO₂ absorption at 2.8 microns
- Differential CO₂ absorption at 4.3 microns
- Solar refraction angle vs. height

Retrievals from the tropopause to 105 km, in the presence of clouds

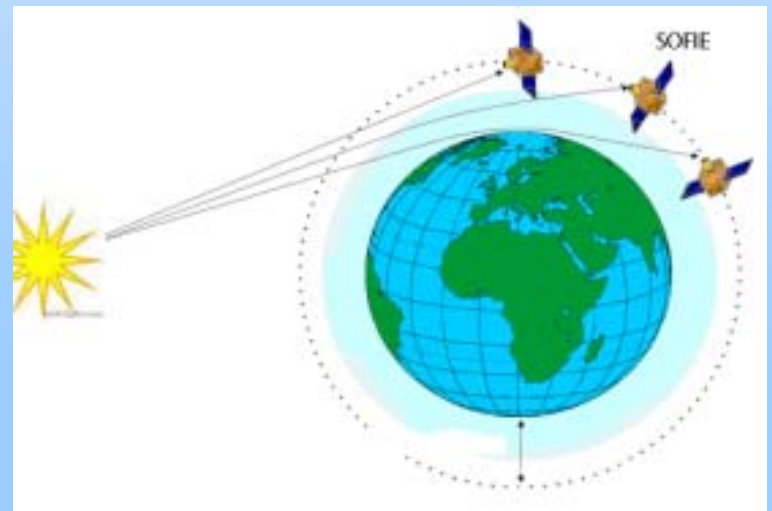
Simultaneous CO₂ retrievals

Height dependence of refraction angle is determined by the temperature profile

Same approach as GPS T retrievals



A8867_019



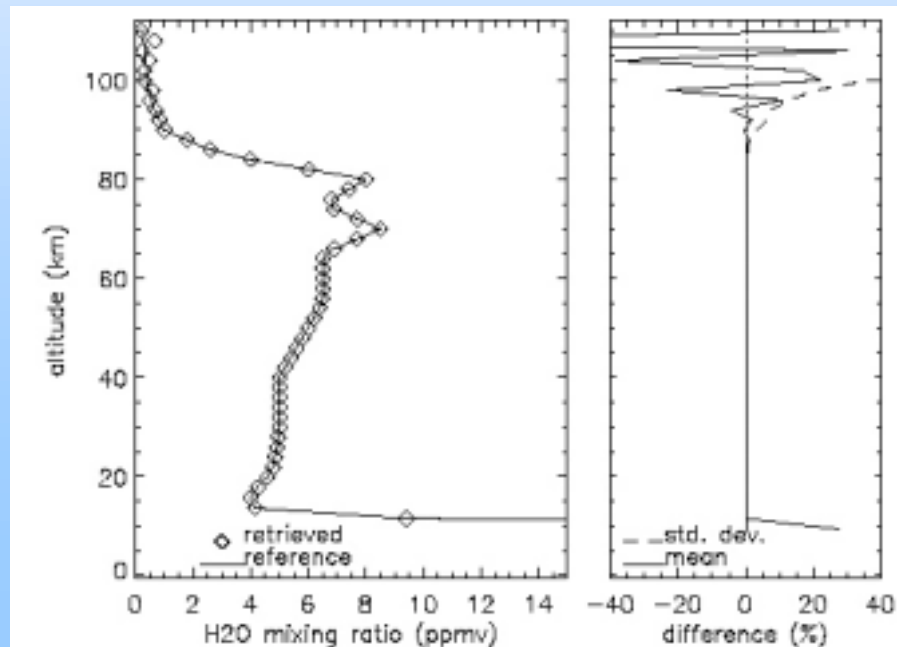
SOFIE Water Vapor Measurements

Based on absorption at 2.45 and 2.60 μm

Immune to clouds and aerosols

Retrievals from tropopause to 90 km

Simulated SOFIE
 H_2O retrieval



SOFIE Particle Measurements

Particle extinctions at 10 wavelengths (290 nm – 5.3 μm):

- Two dedicated particle channels (4 wavelengths)
- Gas channel weak bands (6 wavelengths)

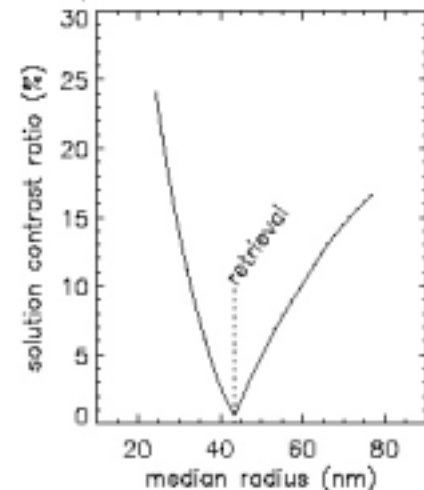
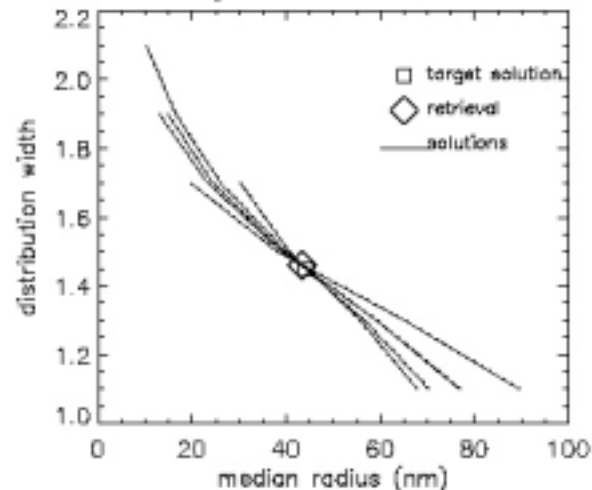
Measurements from the tropopause to the mesopause:

- Primary: NLCs
- Secondary: cosmic dust, PSCs, cirrus, SSA

Unique combination of UV
thru IR wavelengths allows:

- Particle size distribution retrievals
- Inference of particle composition

Simulated NLC size distribution retrieval



Summary

Solar Occultation For Ice Experiment (SOFIE)

- ✓ Onboard AIM, a mission to study noctilucent clouds
 - September 2006 launch
- ✓ Differential Solar Occultation
 - 8 channels, 16 bands
 - High precision
- ✓ Measurements of:
 - H_2O , O_3 , CH_4 , NO , CO_2
 - Particle extinction at 10 λ 's (290 nm – 5.3 microns)
 - Temperature